

# **Science Instruments and Sensors Capability Roadmap Presentation to Robotic and Human Exploration of Mars**

**NASA Chair: Rich Barney, GSFC  
External Chair: Maria Zuber, MIT  
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## Agenda



- **Capability Description**
- **Roadmap Team**
- **Capability Breakdown Structure**
- **Roadmap Approach and Process**
- **Reference Documentation**
- **Science Traceability**
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  - Strategic Roadmap Matrix
- **Capability Roadmap Challenges**



## Capability Description



- **The Science Instrument and Sensor Capability Roadmap Team will investigate current NASA exploration and science measurement strategies, mission formulation concepts, and science instrument/sensor technology roadmaps to identify critical science measurement capability gaps and assess future technology development needs. Specific science instrument and sensor groups include the following:**
  - **Active / Passive Microwave Remote Sensing**
  - **Multi-Spectral Imaging / Spectroscopy**
  - **Laser / LIDAR Remote Sensing**
  - **Direct Sensing of Fields, Waves, and Particles**
  - **In Situ Measurements**
- **This information will be integrated with extensive national science and engineering community input to develop capability roadmaps that will identify driving science missions, science measurement capability needs, and a technology demonstration process that leads to spaceflight. Priority consideration will be given to instrument and sensor technologies that (1) achieve objectives closely aligned with the Exploration Vision and (2) constitute a major capability advancement required to achieve high priority science measurement goals.**



## Capability Roadmap Team



### Co-Chairs

- NASA: Richard Barney, NASA/Goddard Space Flight Center
- NASA Deputy: Juan Rivera , NASA/Goddard Space Flight Center
- External: Dr. Maria Zuber , Massachusetts Institute of Technology

### Team Members

#### Government

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Suzanne Staggs, Princeton

### Other/Independent

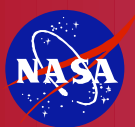
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David Glackin, Aerospace

### Coordinators

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APIO: Perry Bankston, JPL

### Ex-officio

Carl Stahle (GSFC-Nano CRM)  
Louis Barbier (NASA-SEU Technologist)  
Thomas Black(NRO)  
Amy Walton (ESTO)



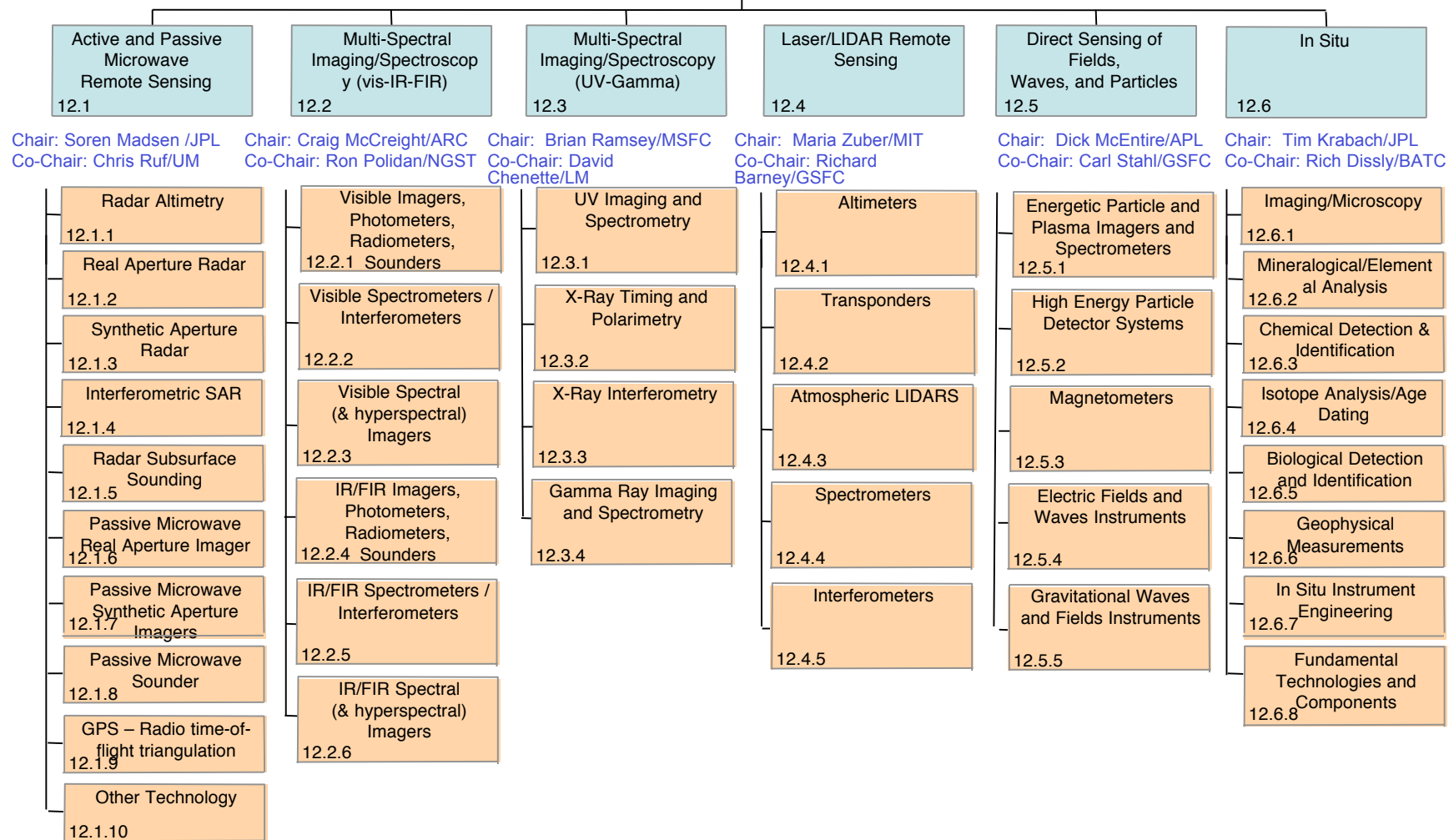
# Capability Breakdown Structure



Science  
Instruments and  
12.0 Sensors

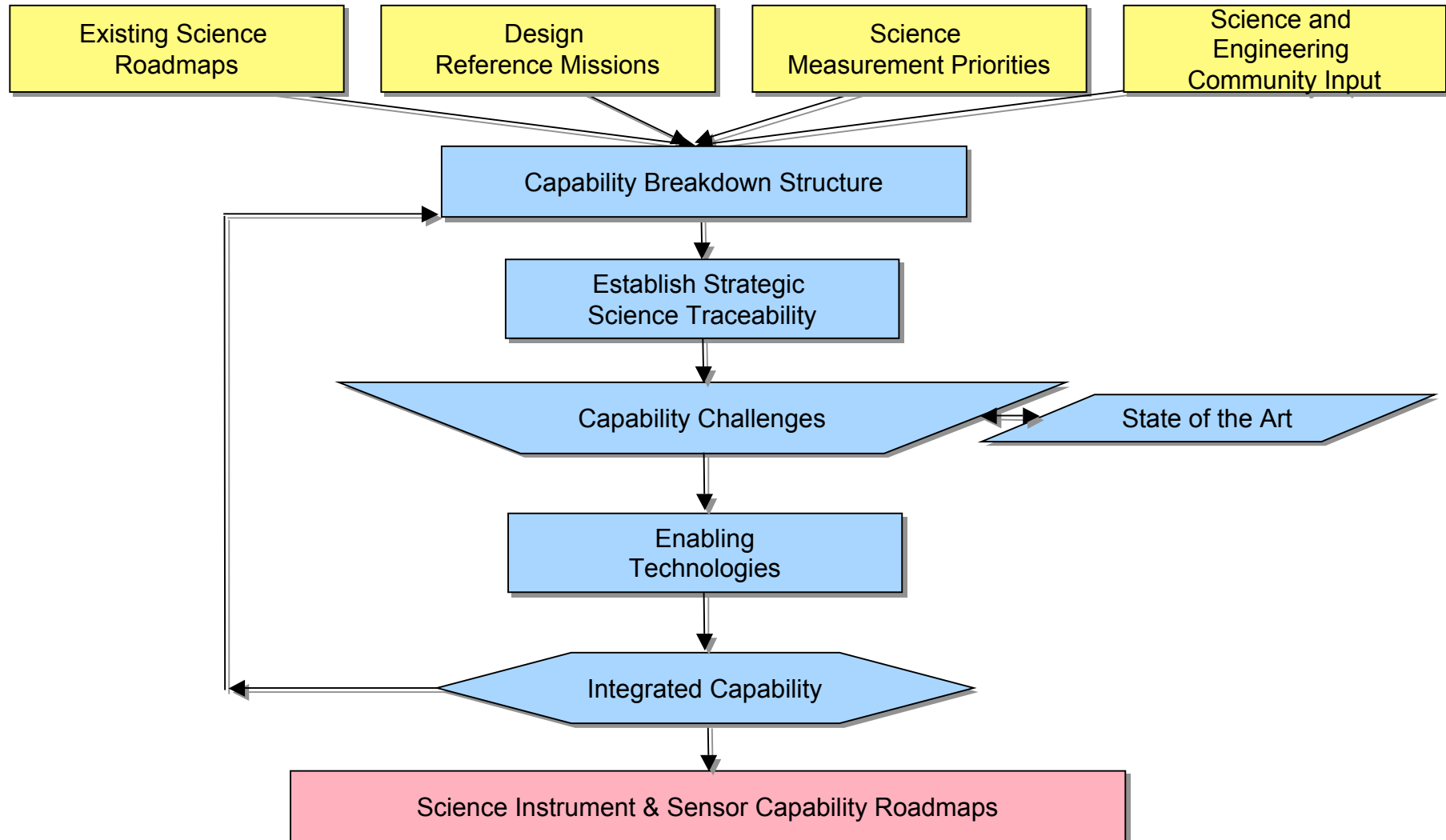
Chair:  
Co-Chair:  
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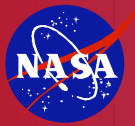
Richard Barney NASA/GSFC  
Maria Zuber  
Juan Rivera NASA/GSFC



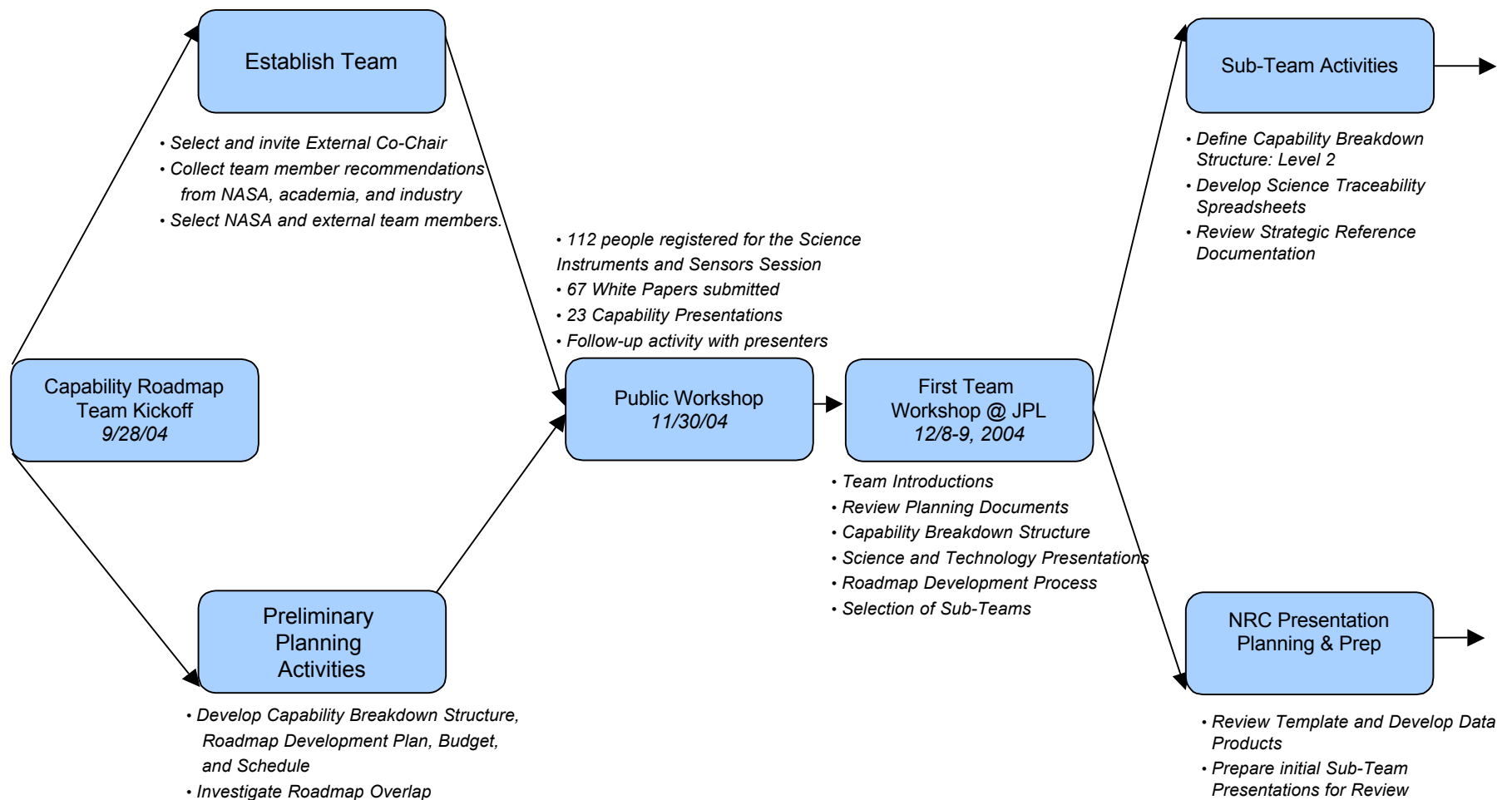


# Roadmap Development Approach



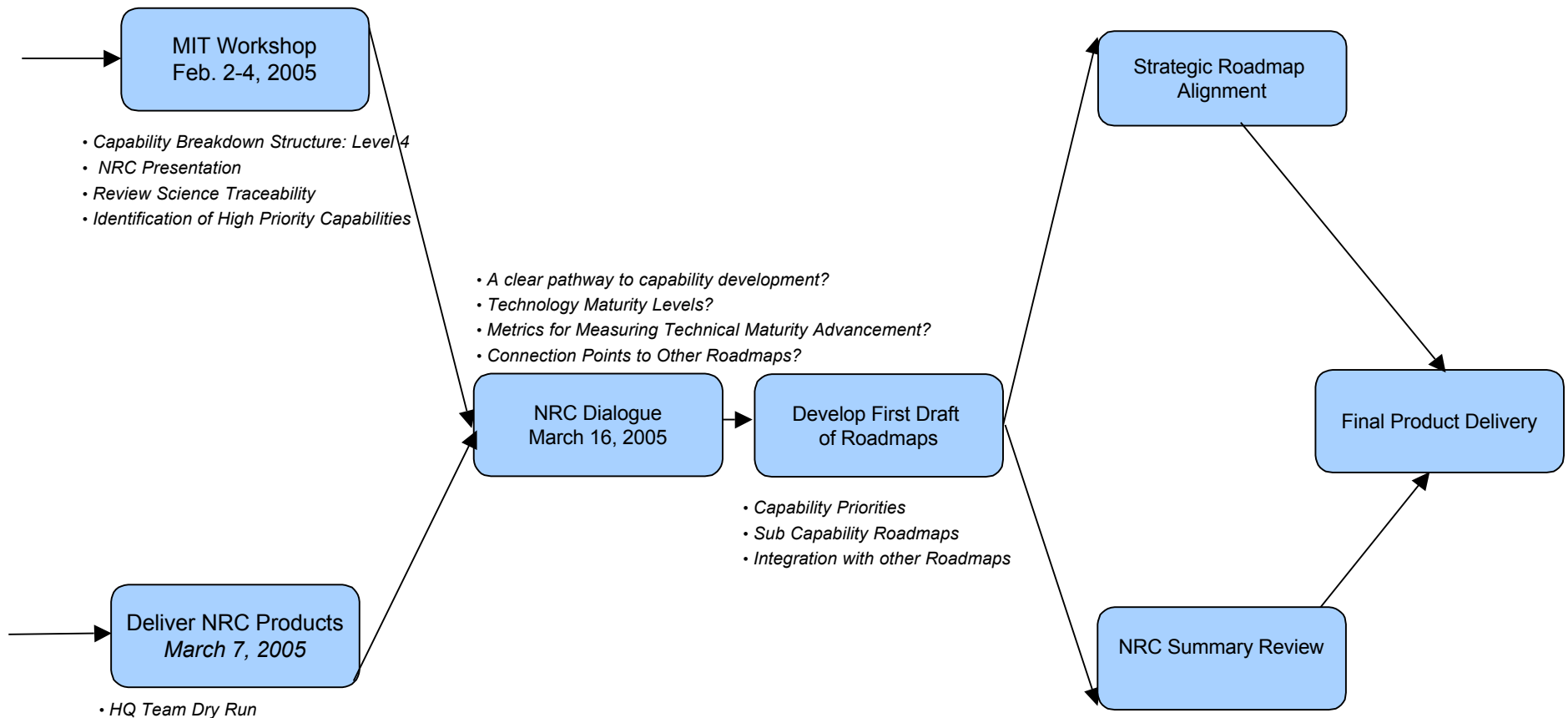


# Roadmap Development Process





# Roadmap Development Process







## Reference Documentation (Docushare Library)



- The Vision for Space Exploration
- A Journey to Inspire, Innovate, and Discover: President's Commission Report
- Our Changing Planet: The US Climate Change Science Program for Fiscal Years 2004 and 2005
- Design Reference Missions
  - APIO DRMs
    - Solar System Exploration - 2000 to 2035 (Draft 3): DRM\_SSE
    - Earth-Sun System: Potential Roadmap and Mission Development Activities (12/23/04)
    - Universe Design Reference Missions (12/13/04)
    - Architecture Study #2, Human Exploration of Mars, Artificial-Gravity Nuclear Electric Propulsion Option (7/15/03)
    - Reference Mission Version 3.0 Addendum to the Human Exploration of Mars (6/01/98)
    - Mars 98 Reference Mission: Reference Mission of the NASA Mars Exploration Study Team (7/7/97)
    - Lunar Surface Reference Missions: A Description of Human and Robotic Surface Activities (07/01/03)
    - The Mars Surface Reference Mission: A Description of Human and Robotic Surface Activities (12/01)
  - Other DRMs
    - Advanced Mission Studies: Mars Exploration Program Analysis Group
      - Astrobiology Field Laboratory-2013 (Biosignature Detection)
      - Ground Breaking Mars Sample Return
      - Mars Deep Drill: Explore Active Hydrothermal Habitats
      - Mars Deep Drill: Search for Evidence of Past Life



## Reference Documentation (Docushare Library)



- Enterprise Strategies
  - Earth Science Application Plan
  - Earth Science Research Plan (*Draft*)
  - Sun-Earth Connection Roadmap (2003-2028)
  - Physics of the Universe: A Strategic Plan for Federal Research
  - Solar System Exploration Roadmap
  - Origins Roadmap (2003)
  - Structure and Evolution of the Universe Roadmap
- National Research Council Reports
  - Astronomy and Astrophysics in the New Millennium Astronomy and Astrophysics Survey Committee, Board on Physics and Astronomy, Space Studies Board
  - Implementing Climate and Global Change Research: A Review of the Final U.S. Climate Change Science Program Strategic Plan Committee to Review the U.S. Climate Change Science Program Strategic Plan
  - New Frontiers in the Solar System: An Integrated Exploration Strategy Solar System Exploration Strategy, NRC
  - Solar and Space Physics and Its Role in Space Exploration Committee on Assessment of the Role of Solar and Space Physics in NASA's Space Exploration Initiative, NRC
  - The Sun to the Earth -- and Beyond: A Decadal Research Strategy in Solar and Space Physics Solar and Space Physics Survey Committee
  - The Sun to the Earth -- and Beyond: Panel Reports Solar and Space Physics Survey Committee, Committee on Solar and Space Physics
  - Connecting Quarks with the Cosmos: Eleven Science Questions for the New Century, Committee on the Physics of the Universe, NRC



# Science Traceability Spreadsheet (Example)



Strategic Roadmap Reference	NASA Science Document Reference*	Science Question	Relevant Missions (Design Reference Mission)	Launch Date	Measurement Parameter	Measurement Scenario	Target Body	Scenario Document Reference*	CBS Reference (Level 1)
1, 2, 3	1	How do the processes that shape the contemporary character of planetary bodies operate and interact?	Mars Upper Atmosphere Orbiter	2010	Measure Energetics of the Ionosphere	Doppler Lidar	Mars	1	12.4
2	4	Characterize the chemical composition of the Martian surface and atmosphere.	Astrobiology Field Laboratory	2019	Determine the chemical and mineralogical composition of the Martian surface and near surface material	LIBS: Laser Induced Breakdown Spectroscopy	Mars	4	12.4
1, 2, 3	1	How do the processes that shape the contemporary character of planetary bodies operate and interact?	Mars Upper Atmosphere Orbiter	2009	Measure Magnetic Reconnections	Magnetometer	Mars	1	12.5
2,3	1	What global mechanisms affect the evolution of volatiles on planetary bodies?	Mars Long-Lived Lander Network	2009	Precise long-lived chemical and isotopic analysis to track the dynamics of Mars's ground-level atmosphere.	Mass Spectrometer Network	Mars	1	12.6
2,3	1	What global mechanisms affect the evolution of volatiles on planetary bodies?	Mars Sample Return	2013	Understanding of the geological evolution of Mars with detailed knowledge of the chemistry, mineralogy, and chronology of the crust, the role of volatiles, and elucidation of the conditions that could potentially have led to the emergence of life on Mars.	Samples from carefully chosen sites will be returned to Earth.	Mars	1, 5	12.6
2	2,3	Characterize the geology (stratigraphy, structure, chemistry) and geophysics of the shallow Martian crust at one site, particularly as it relates to interpreting present habitability.	Mars Deep Drill	2020	Determine as a function of depth the geologic processes which have resulted in deposition, hydrothermal alteration, diagenesis, and tectonic modification of the Martian geologic record	Ice/Water Detector	Mars	2, 3	12.6

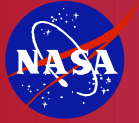
Reference 1: New Frontiers in the Solar System: An Integrated Exploration Strategy (2003)

Reference 2: Mars Deep Drill Search for Evidence of Past Life, Sylvia Miller, John Essmiller, David Beaty, JPL, January 16, 2004

Reference 3: Mars Deep Drill Explore Active Hydrothermal Habitats, Sylvia Miller, John Essmiller, David Beaty, JPL, January 16, 2004

Reference 4: Astrobiology Field Laboratory - 2013 Biosignature Detection, Roger Dhiel, JPL, March 10, 2004

Reference 5: Groundbreaking Mars Sample Return, Richard Mattingly, JPL, March 8, 2004



## SIS CRM Team Concerns



- Parallel development of Strategic and Capability Roadmaps
  - Capability development priority process may lead strategic roadmap guidance and “Exploration” driven Design Reference Missions.
  - Integration process
- Strategic guidance to ensure accurate traceability back to high priority science questions
  - Are we on the right track?
  - Process of prioritizing (Capabilities & Science)
  - Point of contact with the Universe SRM#2?
- Science Instruments and Sensors Capability Roadmaps cover a diverse and broad spectrum.
  - Work load issues with some team members.